



## Problem Solving Ability of First Year High School Students in Mathematics as Affected by Cognitive Development Levels and Teaching Strategies

**Edward C. Jimenez PhD, FRIEdr, CSEE**

**Education Program Supervisor I**

Schools Division of City of Meycauayan

Department of Education

Bulacan, Philippines

[edward.jimenez@deped.gov.ph](mailto:edward.jimenez@deped.gov.ph)

### Abstract

Improving problem solving abilities among students remain to be a challenge among teachers and students. This study aimed to identify problem solving ability of first year students as affected by cognitive development levels and teaching strategies of first year high school students in Mathematics I. The study utilized descriptive and experimental methods. A total of 150 students from three classes in a public secondary school in Central Luzon, Philippines were included. Tools were validated questionnaires to measure problem solving abilities and cognitive development levels. Data were analyzed using frequency, percentage, Mean, Standard Deviation, T-Test, ANOVA, and Regression Analysis. Results showed that the cognitive level of development of the students are satisfactory across all domains ( $X=2.81$ ). Discovery, Exposition, and Traditional Methods of Teaching were found to significantly improve the problem solving ability of the students with a p-value of 0.000 in each group. All groups have no significant difference in performance which may imply that no teaching method is better than the other. Lastly, cognitive domains of the students in knowledge, comprehension, application and evaluation were found to be significant determinants of students' problem solving ability. The study results can be a springboard to improve problem solving abilities of high school students. Cognitive development could be considered as a basis for grouping high school students in all curriculum levels and can be evaluated by future researchers for effectiveness.

### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



\*\*\*\*\*

## Introduction

There are great reasons why the development of the thinking abilities should be the core purpose of education. Education is viewed both as an end and as a means to an end. It is considered a basic human need to provide every citizen the opportunity to be trained, developed and be productive. It trains every citizen to be economically effective and efficient to be able to contribute to rational development. Through the different disciplines of education, every Filipino will be given enough opportunity to develop his/her potentials and skills in mathematics, such as analytical, comprehension, and social skills as well.

The rate of change is so fast. New technologies and discoveries happen faster than we think. One cannot anticipate what content of learning would be relevant 10 or 20 years; hence, we need people who can classify and generalize, analyze and synthesize, compare and evaluate, deduce and infer, and to sum it all, people who have skills in problem solving.

The great purpose of education is not much achieved by our schools. It is pointed out that teachers in the elementary and secondary schools can make a big difference. The bulk of responsibility, however, lies on the hands of colleges and universities who train teachers. The ability to perform their duties depends on the nature of their work and with the parents in identifying objectives, learning opportunities and evaluation procedures in mathematics. That is why the school introduces educative process to meet the needs of the students and of challenging world to be able to produce functional and effective citizens.

As we know that we have our individual differences, students differ in their interest, ability and beliefs. Critics and teachers observed that students who have been devoting much

\*\*\*\*\*

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

## Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



of their time and effort in attaining the mastery of mathematical skills and ideas are those who are willing and eager to learn mathematics.

However, challenges are faced by learners and teachers alike in the attainment of abilities in mathematics. Nichols (2002) stated that one of the many challenges we face as mathematics educators is meeting the needs of students with lower level of performance with a complete balance curriculum and effective instructional strategies. The curriculum and evaluation standards call for a “curriculum that reflects the needs of all students. The core curriculum is intended to provide a common body of mathematical ideas accessible to all students.

Vatter (2002) pointed out that at-risk students are those who fail; who seldom do homework; who are inattentive or who seem unable to benefit from instruction. Their characteristics can be summarized as follows; poor self-concept; poor academic performance; high absenteeism and discipline problems; low aspirations; parents or guardians with low expectations; low family socio-economic level; nontraditional family life; often with a single or foster parent and inadequate goals or lack of future orientation. Vatter emphasized that teachers can help at-risk students find some success if (1) schoolwork is hand-on, (2) students’ feelings of worth and accomplishments are nurtured by the work itself and (3) the risk is tied to real work in the real world. Effective classroom techniques should be developed for responding to those needs.

It cannot be denied that mathematics is such a difficult subject specifically problem solving. With this regard, the researcher decided to find out what level of development of students could serve as predictor of the problem solving ability of the first year students in mathematics I. Specifically, the study sought to answer the following questions: (1) What is

\*\*\*\*\*

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



the problem solving ability of the students as affected by their cognitive development levels; and (2) What is the problem solving ability of the students as affected by the teaching strategies.

Providing significant information about improving the problem solving ability of students and how it is affected by the cognitive development levels and the teaching strategies may benefit the school administrators, teachers, students and their parents, the community and future researchers.

This study is envisioned to help the administrators and teachers by providing them information regarding the status of the first year high school students in terms of their cognitive development learning in problem solving level. Understanding how students think and learn at a certain age will serve as better guides in the adventure of learning. The students will be encouraged to improve problem solving abilities and strengthen their weaknesses. Also, parents are provided with information and encouragement to help and guide their children in learning mathematics effectively. Lastly, the study will serve as a point of reference for those who would want to make further investigation on similar problems.

## Methodology

This is an experimental research that utilized pre-test and post test design to measure the problem solving ability of first year students in Mathematics I as affected by cognitive development levels and teaching strategies.

This study was conducted in a public school in Central Luzon, Philippines. The respondents include the first year students. The target respondents in the school composed of five classes. The researcher used three out of the five classes which were chosen based

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

## Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



on the availability of schedule given by the principal and the mathematics teachers in accordance to the implementation of the three teaching strategies. A total of 150 first students were included, 50 students per class. The researcher coordinated with the high school principal, first year mathematics teachers and class advisers handling the students, in the collection of data for the study.

The main concern of this study was to get information from the students and teachers in a public school in Central Luzon, Philippines. As regards to problem solving ability of the students in Mathematics I as affected by cognitive development levels and teaching strategies, the researcher submitted a letter of request to the principal and requested the principal's referral to the Division Superintendent regarding this study. Having been given the referral, the researcher forwarded the request to the office of the Schools Division Superintendent for the implementation of this study. Right after the receipt of the approval, the researcher arranged with the school principal and mathematics teachers regarding the schedule of data gathering. The schedule was set in accordance with the mathematics teachers and students' available time considering the terms and conditions in administering the study that there should be no interruption of classes and no collection of fees from the students.

The students' pre-tests and post tests were constructed by the researcher based on the lessons in Mathematics I and validated by administering to two first year sections for two weeks which were not included in the conduct of the study. Likewise, the cognitive development test which was answered by the mathematics teacher respondents were derived and patterned from Bloom's cognitive learning taxonomy (Fallahi, et. al. 2009) which enhances communication based from six hierarchical levels of learning while the questions for the cognitive development test were based on the second grading period lessons and skills which was the coverage of the conducted study.

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



The pre-tests and post tests and cognitive development tests were all checked as to its validity by five experts which include a University professor, a Dean of the Graduate Studies Program, Principal, and experienced mathematics teachers before the implementation of the instruments.

The data gathered were treated statistically using mean, standard deviation and multiple regression analysis to find out the problem solving ability in Mathematics I as affected by cognitive development levels. Weighted mean, standard deviation, t - test and ANOVA were used to determine the problem solving ability in Mathematics I as affected by teaching strategies.

## Results

### Cognitive Level of Development of the Students

The result of the mean scores of the students in their cognitive levels of development is presented in Table 1. The table reveals the summary of the evaluation of teachers with regard to the cognitive development levels of the student respondents in terms of knowledge, comprehension, application, analysis, synthesis, and evaluation. Among these items, “knowledge” was evaluated as the highest with a computed weighted mean of 3.01 and standard deviation of 0.07 followed by “comprehension” with a mean of 2.82 and had a standard deviation of 0.10, “application” with a mean of 2.79 and standard deviation of 0.06, “analysis” and “evaluation” both had a mean of 2.75 but with different standard deviations, while “synthesis” was the lowest among the cognitive development with a computed weighted mean of 2.71 and standard deviation of 0.06. All items were verbally interpreted as “satisfactory”.

### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

### Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco





\*\*\*\*\*

Among the items, “Name the kinds of polygon” was rated the highest with a computed mean of 3.14 while item number 6, “Match the mathematical problems into other kinds of problems” was rated the lowest with a computed weighted mean of 2.89. The overall weighted mean was computed at 3.01. All items were verbally interpreted as “satisfactory”.

In terms of comprehension, item statement number 1, “Rewrite the formula on the equation” was rated the highest with a weighted mean of 2.95 while item statement number 10, “Estimate the answer of the problem” was rated as the lowest with a weighted mean of 2.67. The overall weighted mean was computed at 2.82 with a verbal interpretation of “satisfactory”.

In terms of application, the item “Compute the value of x” was rated as the highest with weighted mean of 2.93, while item number 7, “Modify the problem being asked” was rated as the lowest with a computed mean 2.71 The overall weighted mean was tabulated at 2.79 and verbally interpreted as “satisfactory”

With regards to application, item number 3, “Diagram the rational numbers” was rated as the highest with a weighted mean of 2.89 while the lowest item statement was item number 6, “Select important details from unimportant details to find the correct answer” with a weighted mean of 2.65 which had a verbal interpretation of satisfactory. As can be seen in Table 11, all item statements were tabulated and had an overall weighted mean of 2.75 and were verbally interpreted as “satisfactory”.

The cognitive development level of student respondents in terms of synthesis reveals that item number 9, “Compile mathematical materials sufficiently” was rated as the highest item statement with a weighted mean of 2.83, while item number 8, “Generate hypothesis of

\*\*\*\*\*

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



\*\*\*\*\*

the problem” was rated as the lowest item statement with a weighted mean of 2.63. The overall weighted mean of the cognitive development level in terms of synthesis as evaluated by teachers was 2.71. All the items were verbally interpreted as “satisfactory”.

Lastly, result of the students’ cognitive level in evaluation domain, Item number 1, “Select the most effective solution” ranked first with a computed mean of 2.87 while items numbers 6 and 10, “Evaluate the result of problem solved” and “Relate the mathematical ways in solving mathematical problems to personal ways in solving personal problems” were rated the lowest with a computed weighted mean of 2.63. The overall weighted mean was computed at 2.75. All items were verbally interpreted as “satisfactory”.

**Table 1.** *Cognitive Level of Development of the Students*

Cognitive Domain	Mean (SD)	Verbal Description
1. Knowledge	3.01 ( $\pm 0.074$ )	Satisfactory
2. Comprehension	2.82 ( $\pm 0.097$ )	Satisfactory
3. Application	2.79 ( $\pm 0.064$ )	Satisfactory
4. Analysis	2.75 ( $\pm 0.074$ )	Satisfactory
5. Synthesis	2.71 ( $\pm 0.056$ )	Satisfactory
6. Evaluation	2.75 ( $\pm 0.080$ )	Satisfactory
Overall Weighted Mean	2.81	
Verbal Description	Satisfactory	

## **Problem Solving Ability of Students as grouped according to the teaching Methods**

The scores of the problem solving ability of the students before and after the teaching methods are presented in table 2. In terms of the scores of students who underwent discovery method, it can be noticed from the table that in the pre-test, majority of the student respondents or 84 percent (126 out of 150) of them obtained scores ranging from 13 to 24 which was verbally interpreted as “below average”, 15 or 10 percent got scores from 0 to 12 which was verbally interpreted as “low” and only 9 or 6 percent registered scores from 25 to 36 with a

\*\*\*\*\*

### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*





verbal description of “average”. The overall weighted mean was computed at 17.66 which was verbally described as “below average” with a standard deviation of 4.91. This standard deviation measures the spread of the scores from the mean. This means that about 68 percent or 102 student respondents obtained scores ranging from 22.57 to 12.75.

Further analysis of the data reveals that in the post test, majority of the student respondents or 44 percent (66 out of 150) of them obtained scores ranging from 25 to 36 which was verbally interpreted as “average”, 42 or 28 percent got scores ranging from 13 to 24 with a verbal description of “below average”, 33 or 22 percent obtained scores from 37 to 48 which was verbally described as “average”, and only 9 or 6 percent obtained scores ranging from 49 to 60 which was verbally described as “high”. The overall weighted mean in the post test was computed at 31.32 with standard deviation of 8.93 and verbal description of “average”. The computed standard deviation in the post test was higher than the computed standard deviation in the pre-test. This result disclosed that variability in the scores of the student respondents in the post test was greater than the pre-test.

Among students who have been taught through exposition method, majority or 76 percent (114 out of 150) of the student respondents obtained scores ranging from 13 to 24 which is verbally described as “below average”, 24 or 16 percent registered scores from 0 to 12 with a verbal description of “low”, and 12 or 8 percent got scores ranging from 25 to 36 which is verbally described as “average”. The overall weighted mean was computed at 16.80 with a standard deviation of 4.44 and verbally described as “below average”.

The same table presents the distribution of scores of student respondents in the post test under exposition teaching method. It can be gleaned from the table that majority of the

\*\*\*\*\*

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



student respondents, that is 52 percent or 78 out of 150 obtained scores from 25 to 36 which is verbally described as “average”, 33 or 22 percent registered scores from 13 to 24 with a verbal description of “below average”, and a considerable portion, 39 or 26 percent obtained scores ranging from 37 to 48 which was verbally described as “above average”. The overall weighted mean was registered at 30.70 with a standard deviation of 7.65 which was verbally described as “average”.

The distribution of scores of pre-test and post test under the traditional method of teaching is shows that 82 percent of the student respondents or 123 out of 150 obtained scores ranging from 13 to 24 which is verbally described as “below average”, 3 student respondent or 2 percent registered score from 0 to 12 with a verbal description of “low”, and 24 or 16 percent obtained scores ranging from 25 to 36 which is verbally described as “average”. The overall mean for pre-test was computed at 20.16 with a standard deviation of 4.41 and verbally described as “below average”.

Further perusal of the table shows that in the post test majority of the student respondents or 48 percent (72 out of 150) registered scores ranging from 25 to 36 which is verbally described as “average”, 60 or 40 percent obtained scores ranging from 37 to 48 which is verbally interpreted as “above average”, 15 or 10 percent got scores of 13 to 24 and only 3 student registered score of 49 to 60 which is verbally described as “high”. The overall weighted mean was computed at 33.96 with a standard deviation of 8.29 and verbally interpreted as “average”.

\*\*\*\*\*

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



**Table 2. Problem Solving Ability of Students as Grouped According to the Teaching Methods**

Scores	Discovery		Exposition		Traditional	
	Pre-test f(%)	Post test f(%)	Pre-test f(%)	Post test f(%)	Pre-test f(%)	Post test f(%)
49 – 60	0	9 (6%)	0	0	0	3 (2%)
37 – 48	0	33 (22%)	0	39 (26%)	0	60 (40%)
25 – 36	9 (6%)	66 (44%)	12 (6%)	78 (52%)	24 (16%)	72 (48%)
13 – 24	126 (84%)	42 (28%)	114 (84%)	33 (22%)	123 (82%)	15 (10%)
0 – 12	15 (10%)	0	24 (10%)	0	3 (2%)	0
Mean (SD)	17.66 (4.91)	31.32 (8.93)	16.8 (4.44)	30.7 (7.65)	20.16 (4.41)	33.96 (8.29)
Interpretation	Below Average	Average	Below Average	Average	Below Average	Average

## Differences Between Means of Pre-test and Post test

Table 3 shows the differences between means of the pre-test and post test in the discovery, exposition and traditional methods of teaching. A paired (samples) t-test was used to determine the significance of the differences between means. The results indicated that the mean of the pre-test were statistically significantly different from the mean of post test as indicated in the probability value of 0.000 which was interpreted as “highly significant”.

**Table 3. Differences Between Means of Pre-test and Post test**

Teaching Method	Mean		Mean Difference	t - value	Probability
	Pre-test	Post test			
Discovery	17.66	31.32	- 13.66	- 12.62	0.000**
Exposition	16.80	30.70	- 13.90	- 18.10	0.000**
Traditional	20.16	33.96	- 13.80	- 13.86	0.000**

Legend: \*\* - highly significant

As can be noted from the table, exposition teaching method registered the highest mean difference of 13.90 followed by the traditional method, with a mean of 13.80 and the lowest was the mean for discovery method, 13.66. With regard to the variability of the scores

\*\*\*\*\*

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



of the student respondents, the same table and figure reveals that the spread of the scores about the mean was less in the exposition method as indicated by the computed standard deviation of 5.43.

## Differences Among Means of the Three Types of Teaching Methods

To test the difference among the mean of the three types of teaching methods, the analysis of variance was employed. The results are indicated in Table 7. A closer look at the table reveals that there is no significant difference among the means as indicated by the F value (0.02) which is less than the F critical value of 3.06. Results disclosed that the performance of the student respondents in the three types of teaching methods is almost the same. This indicates that no teaching strategies is considered best, it depends on the learning situation, learning environment, the students and the teacher itself.

**Table 7.** Differences Among Means of the Three Types of Teaching Methods

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F	Significance
Between Groups	1.45	2	0.73	0.02	0.98 (ns)
Within Groups	6743.72	147	45.88		
Total	6745.17	149			

Legend: ns – not significant F value < F crit (3.057621)

## Significant Correlates on the Students' Achievement in Problem Solving

The identification of the significant correlates of students' achievement in problem solving in mathematics has been the major concern of this study. The independent variables, teaching methods and the students' cognitive development levels were correlated with the dependent variable which is the students' achievement in problem solving (worded problems in mathematics). Teaching methods were broken into three (3): (1) discovery, (2) exposition,

### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



and (3) traditional method. The cognitive development levels that were considered are as follows: (1) knowledge; (2) comprehension; (3) application; (4) analysis; (5) synthesis; and (6) evaluation.

Table 8 shows that out of three teaching methods only traditional method was found to be a significant determinant of the level of achievement of student respondents in problem solving. Discovery and exposition were not found significant in relation to the level of achievement of student respondents in problem solving.

**Table 8.** *Regression Analysis of Students' Performance in Problem Solving on Teaching Methods*

	<b>Beta Coefficient</b>	<b>Significance</b>
Discovery	- 0.16	0.46 ns
Exposition	0.42	0.17 ns
Traditional	0.60	0.05 *

Multiple Correlation Coefficient (R) = +0.13741

Coefficient of Determination ( $R^2$ ) = 0.01888

ns,  $p > 0.05$ , not significant

• , significant,  $p < 0.05$

Further examination of Table 8 reveals that traditional method is positively and significantly correlated with students' achievement in problem solving. This was shown by the beta coefficient of 0.60 with a probability of 0.05. This means that employing traditional method of teaching resulted to a positive outcome in the achievement of students in problem solving. However, this teaching method was found not significant as indicated by the probability value of 0.17.

It was also indicated in the table that exposition is positively correlated with students' achievement in problem solving as indicated by its beta coefficient of 0.42. On the other hand, discovery resulted into a negative beta coefficient of - 0.16. This means that an increase of

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



0.16 in problem solving achievement can be expected for every decrease in unit in discovery teaching method.

The multiple correlation coefficient of +0.14 is the linear correlation between the teaching methods and students' achievement in problem solving. Its low value indicated a negligible correlation between the variables.

The coefficient of determination or the squared value of multiple correlation coefficient measures the joint impact of the three teaching methods in explaining the variation in students' achievement in problem solving. The value of 0.02 shows that only 1.88% of the variation in achievement in problem solving is accounted for or explained by the variation in teaching methods.

According to Jansen (2005), intervention is an important method for the teachers to make sure the students succeed in assessments that determine their knowledge, skills and ability to solve problems. As cited by Berches (2005) in her study about Mapping of Difficulties with Strategies in Algebraic Problem Solving, found out that drills and exercises with incentives given to students, intensive assignments and frequent evaluation were found effective since all the t-values exhibit high level of significance in differentiating the pre-test from the post test results.

Furthermore, Choate (2000) cited that some instructional strategies are effective for all types of learners, and these present the obvious and easiest opportunities for inclusive teaching and learning. He also emphasized that effective teacher structure learning tasks should be accessible to students and should enhance academic learning time. These two principles suggest several practices: Allot more time for instruction by scheduling carefully and

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

## Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco





managing instruction efficiently; and ensure that students are actively engaged in each learning activity by including, interaction learning experiences.

It is also important to still consider enriching lessons with exploratory and visual materials, verbal problems, use of symbols in teaching mathematics that help in improving the skills of the pupils in problem solving (Cagaan, 2003). At the same time, the use of mathematical sentences in solving single and multi-step story problem is recommended (Marco, 2003).

**Table 9.** *Analysis of Variance of the Regression of the Students' Performance in Problem Solving on Teaching Methods*

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
Regression	533.46	3	177.82	1.53	0.22 ns
Residual	5357.76	46	116.47		

ns,  $p > 0.05$ , not significant

The results reveal that taken jointly the three teaching methods: discovery, exposition, and traditional, together with the achievement in problem solving did form an insignificant value of F statistics that is 1.53 with a significant value of 0.22. This means that the variation in achievement in problem solving explained by the teaching methods is due to mere chance.

The finding of this study is similar to the study of Matheson (2009) entitled The Predominant Teaching Strategies in Year 8 and Year 9 Mathematics Classrooms where she found out that teachers have a great influence in the appropriate teaching strategies to understand the lesson better. She stressed that Year 8 teachers used facilitating and eliciting questions more often than Year 9 teachers. This means that teacher's competency plays an important role in choosing and using an appropriate teaching strategy that best suits the lesson.

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



The study of Matheson (2005) favors the result of this study. Both studies concluded that teacher's competencies have a distinct factor that helps the students to cope and understand the world of learning better using different appropriate teaching strategies that elicit the students' interests and awareness. Furthermore, Jansen (2005) also said that no single instructional strategy is more than effective, appropriate, and informative assessment. It is necessary on the part of the teachers to know the students' understanding and mastery of content.

Varying teaching strategies continue to strongly affect student performance. Erlano (2002) studied the strategies used by teachers and determined the performance of students based on strategy used. His findings revealed that the most used strategies include dynamics, practical work approach, discovery, drill method and problem solving approach. Based on the findings, students' performances in all the components of mathematics IV were all average.

Turtoga (2001), in her write-up stated that for a meaningful and effective learning on how to solve problems, learners should acquire skill, understanding and insights. She recommended the three types of teaching, namely: (1) Teaching by rule, where teacher states the rule, performs several exercises to show its application, and learners perform exercises until they will always remember the rule and will apply it correctly in solving problems; (2) Meaningful lectures, where teacher explains and illustrates every step and the pupils follow faithfully and finally learn the rule; and (3) Discovery Method, where the learners try to solve the problems and go through the given facts step by step until they finally come to the solution and thereby get an insight into the mathematical concept involved and perhaps state it in their own words according to their understanding of the process they have performed in the solution of the problem.

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



\*\*\*\*\*

**Table 10.** *Regression Analysis of Students' Ability in Problem Solving on their Cognitive Development Levels*

	Beta Coefficient	Significance
Knowledge	0.27	0.03 *
Comprehension	0.93	0.01 **
Application	0.63	0.00 **
Analysis	0.64	0.09 ns
Synthesis	0.67	0.09 ns
Evaluation	0.74	0.03 *

Multiple Correlation Coefficient (R) = +0.54540

Coefficient of Determination ( $R^2$ ) = 0.29746

ns,  $p > 0.05$ , not significant

\*\*,  $p < 0.01$ , highly significant

\*,  $p < 0.05$ , significant

Table 10 indicates that among the six cognitive levels of development, application and comprehension were found highly significant determinants of problem solving ability of the students with probability values of 0.00 and 0.01, respectively. Other two items, knowledge and evaluation were also found significant as indicated by its probability values of 0.03 and 0.03, respectively. On the contrary, analysis and synthesis were found not significant determinants of students' problem solving ability as reflected by its probability values of 0.09 and 0.09, respectively.

Further perusal of Table 18 reveals that all indicators, knowledge, comprehension, application, analysis, synthesis, and evaluation are positively correlated with the ability of the students in problem solving as reflected by its beta coefficients of 0.27, 0.93, 0.63, 0.64, 0.67, and 0.74, respectively. This means that these determinants had a direct correlation with students' ability in problem solving.

A multiple correlation coefficient of +0.55 shows the degree of correlation between cognitive development levels of the students and their achievement in problem solving. This

\*\*\*\*\*

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

## Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



indicates that marked or moderate correlation exists between the aforementioned variables. Likewise, direct correlation exists between these variables since the multiple correlation coefficient is positive.

A coefficient of determination of 0.3, which is the square value of the multiple correlation coefficient, resulted from the regression run shows that about one out of three variations in the ability of students in problem solving is accounted for or explained by the variation in cognitive development level.

Table shows the analysis of variance of the regression of students' achievement in problem solving on the six cognitive development levels.

**Table 11.** *Analysis of Variance of the Regression of the Students' Ability in Problem Solving on their Cognitive Development*

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
Regression	4.38	6	0.73	3.03	0.01 *
Residual	34.41	143	0.24		

\*\*,  $p < 0.05$ , significant

The results reveal that taken jointly the six cognitive development levels: (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation together with the students' ability in problem solving did form a significant value of F statistics that is 3.03 with a probability value of 0.01. This means that the variation in the students' ability in problem solving explained by the cognitive development levels is not due to mere chance.

Developing understanding in Mathematics is important but a difficult goal. Being aware of the difficulties and sources of the difficulties and designing instruction to diminish them are important steps in achieving this goal. Esteban (2003) suggested a translation activity wherein pupils are led to translate the essentials into a mathematical sentence.

#### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco



\*\*\*\*\*

According to Gutierrez (1994) in her study in Relationship of Specific Reading Comprehension Skills and Mathematical Problem Solving Abilities of Grade V Pupils revealed that problem solving ability of Grade V pupils is significantly related to specific reading comprehension skills. She stressed that to improve the pupils' solving skills, reading comprehension skills must be improved first. The Comprehension on Relational Phrases and Clauses as a Factor of Problem Solving Ability in Mathematics by Yared (2003) found that English-proficient students experience both semantic and linguistic difficulties. While semantic difficulty stems from the failure to understand the everyday English language, mathematical linguistic difficulty is generally characterized by a failure to recognize and distinguish between mathematical phrases and clauses, and the major and minor ideas that they imply. As a consequence, students are unable to recognize variables and operations that are implicit in prepositions.

Yap (2003) revealed that the teaching of estimation strategies enhances pupils' quantitative judgment and problem solving ability. Exposing the pupils to the different estimation strategies develops a more positive attitude towards the use of estimation. He also found out that it provides evidence that there are abilities that are significantly related to quantitative judgment and problem solving.

Another study conducted by Borucki (2005) found that there was a significant main effect for cognitive level for vocabulary and for reading and a significant sex-by-level interaction for reading comprehension. This means that there were significant differences in achievement, favoring the girls in the sample, for word reading, reading comprehension, word study skills, and total reading.

The result of the present study stresses the significant effect of problem solving ability in Mathematics I as affected by cognitive development of the first year students. However,

\*\*\*\*\*

#### **Editorial Team**

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

#### **Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



they only differ in the kind of respondents, location, learning environment and learning situation. Astillero (2004) on the other hand, focused on the difficulty of the students in solving worded problems in College Algebra. He further emphasized that the behavior of the students is the main factor to their difficulty. On the other hand, testing instrument and teacher factor were only secondary.

This study has some limitations. It is concerned only with the identification of the problem solving ability of the first year students as affected by cognitive development levels and teaching strategies employed by the teacher. Only selected first year enrollees of this school year were chosen as respondents. This study was limited only to the group under study and did not attempt to make general conclusions; thus, it cannot conclude that learning difficulties encountered by the subjects of the study were true for all first year students.

## Conclusions

Based on the findings of the study, the following conclusions were drawn: (1) Cognitive Level of Development of the Students were found Satisfactory in all domains; (2) Discovery, Exposition, and Traditional methods were found effective in teaching mathematics depending on the competency of teacher; (3) Application, comprehension, knowledge and evaluation were found highly significant and significant determinants of students' problem solving ability; and (3) The students' performance in mathematical problem solving is not significantly affected by teaching strategies employed by the teacher.

\*\*\*\*\*

## Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

## Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*





## Recommendations

In the light of the above conclusions, the following recommendations are hereby offered by the researcher: (1) A study be made to determine and identify the effective teaching approach in Mathematics for learning situations which will ensure the students enjoyment in learning Mathematics; (2) Discovery, Exposition, and Traditional methods should use by teachers in teaching mathematics; (3) Mathematics teachers especially the non - mathematics major should attend more training/seminar-workshop on different teaching strategies in Mathematics for better teaching competency; (4) The cognitive development levels should be considered and included as one of the bases or criteria for grouping and classifying high school students in all level of the curriculum; (5) Teachers should have constant meeting with the students' parents to strengthen the cognitive development levels of the children; and (6) Educational planners, school administrators, mathematics teachers and parents must be enjoined to participate in the planning and organization of school curricula and activities as well as policies and rules to be implemented, for effective learning in Mathematics and other subject areas.

\*\*\*\*\*

### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

### Manuscript Editors / Reviewers:

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*



\*\*\*\*\*

#### References

- Astillero, Roderick B. "Common Difficulties of Engineering Students in Solving Worded Problems in College Algebra". Sorsogon State University, 2004.
- Berches, Cristina S. "Mapping of Difficulties with Strategies in Algebraic Problem Solving". Pamantasan Lungsod ng Maynila, 2005.
- Borucki, Diane Marie. Relationship of Piaget's Stages of Cognitive Development to First Grade Reading Achievement, (<http://www.eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp.html>), 2005
- Cagaan, Daisy E. "Essential Theories of Mathematics Instruction." **The Modern Teacher**. January 2003
- Choate, Joyce S. **"Successful Inclusive Teaching: Proven Ways to Detect and Correct Special Needs."** A Pearson Education Company, 2000.
- Esteban, Emeterio. "Translation – Key to Success in Solving Mathematical Problem." **The Modern Teacher**, Volume XXXII, No. 3, October 2003
- Fallahi, C. et. al. (2009). The Evolution of Educational Objectives: Bloom's Taxonomy and beyond. Retrieved from <https://eric.ed.gov/?id=EJ883718>
- Gutierrez, Petronila. "Relationship of Specific Reading Comprehension Skills and Mathematical Problem Solving Abilities of Grade V Pupils". Tarlac State University, 1994.
- Jansen, Heidi. Intervention Strategies for Mathematics Teacher. ([http://www.glencoe.com/sec/teachingtoday/subject/intervention\\_strategies.html](http://www.glencoe.com/sec/teachingtoday/subject/intervention_strategies.html))
- Marco, Florida B. "Correlation between Students' Perceived and Actual Learning Difficulties in Math IV", (Seminar Proper). Bulacan State University, 2003.
- Matheson, Kay Jacqueline. The Predominant Teaching Strategies in Year 8 and Year 9 Mathematics Classrooms (<http://hdl.handle.net/10063/965.html>), 2009.
- Nichols, Beverly. "We Need Good Mathematics for all Students". **Mathematics Teachers**. Volume 85, No. 4, April, 2002.
- Turtoga, Erlinda E. "Creative Teaching in Mathematics". **The Modern Teacher**. October 1991.
- Yap, Aida I. "Effects of Teaching Estimation Strategies on Grade Six Pupils Quantitative Judgment and Problem Solving Ability". University of the Philippines, 2003.
- Yared, Jocelyn A. "Comprehension on Rational Phases and Clauses as a Factor of Word Problem Solving Ability in Mathematics". University of the Philippines, 2003.

\*\*\*\*\*

#### Editorial Team

**Editor-in-Chief:** Alvin B. Punongbayan

**Associate Editor:** Camille P. Alicaway

**Managing Editor:** Katherine Joy P. Alicaway

**Web Editor:** Nikko C. Panotes

**Manuscript Editors / Reviewers:**

Chin Wen Cong, Andro M. Bautista, Pinky Jane A. Perez, Mary Jane B. Custodio, Christopher DC. Francisco

\*\*\*\*\*